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A Research Approach to Solving Fish/Forestry Interactions in Relation to Mass Wasting on the Queen Charlotte Islands

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ABSTRACT

Research in the Fish/Forestry Interaction Program was initiated in 1981 by the British Columbia Ministry of Forests, B.C. Ministry of Environment, and Canada Department of Fisheries and Oceans to resolve the conflicts between steep slope logging and the integrated management of fish and forest resources on the Queen Charlotte Islands. The overall objectives of the program include understanding harvest impacts on fisheries habitat and forest sites; minimizing logging-induced slope instability through the use of alternate logging methods; and mitigating the damage caused by landslides with the use of stream and forest site rehabilitation techniques. The program consists of four component research projects which are being carried out in phases over the next 4-year period. The research components are closely integrated within two broad categories of study:

1. impact studies - to document the fish habitat damage and loss in forest site productivity due to soil mass movements; and
2. prescriptive studies - to assess the suitability of alternative techniques both for reducing slope instability caused by logging, and for rehabilitating stream and forest sites damaged by landslides.

Field research, initiated in June 1981, provided a data base for evaluating alternative research strategies, developing a stratification methodology for extrapolation of study results, and determining the site descriptors required to assess impacts. This report describes the research approach and methodology adopted in this major interdisciplinary program.

ACKNOWLEDGEMENTS

A research effort as complex as the Fish/Forestry Interaction Program could not be accomplished without the dedicated involvement of many people.

We wish to express sincere gratitude for the guidance provided by members of the program Steering Committee, including W. Young, B.C. Ministry of Forests; F.C. Boyd, Canada Department of Fisheries and Oceans; A. Murray and E. Anthony, B.C. Ministry of Environment; G.V. Wellburn, Forest Engineering Research Institute of Canada; and Ross Macdonald, Canadian Forest Service. The strength, energy, and direction of this group have moved the program from the planning stage, through the maze of jurisdictions, into a structure for practical problem solving.

Special recognition is due the multi-agency Technical Advisory Committee, which laid the groundwork for this program. It maintains an active role in the program's implementation by providing essential technical supervision and support. Committee participants include: T. Baker, D. Wilford, J. Schwab, T. Dyer, and D. Toews of the B.C. Ministry of Forests; J. Walker and K. Moore of the B.C. Ministry of Environment; J. Lamb, M. Brownlee, L. Powell, and A. Cowan of the Canada Department of Fisheries and Oceans; and G.V. Wellburn of the Forest Engineering Research Institute of Canada.

Members of the study team have the benefit of consultation with a Scientific Advisory Panel composed of senior scientists from government, industry, and academia in British Columbia and the U.S. Northwest. We are very grateful to those who are sharing their time, knowledge, and experience in this capacity: J. Cederholm, Washington Department of Natural Resources; M. Church, University of British Columbia; D. Swanston, U.S. Forest Service; G. Hartman, Pacific Biological Station; R. Chisholm, British Columbia Institute of Technology; and B. Bourgeois and P. Cottell, MacMillan Bloedel Limited.

There are many others, particularly in the sponsoring government agencies and communities on the Queen Charlotte Islands, who are providing support and services that facilitate the efforts of the study team. This report is a result of the combined contributions of all who are participating, both directly and indirectly, in the Fish/Forestry Interaction Program.

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1 INTRODUCTION

Timber harvesting is British Columbia's leading resource industry, employing nearly one in 10 of the province's work force. The importance of wood production to the provincial economy, and the need to maintain a steady supply of timber and jobs, results in immense social and economic pressures on the forest land base. On the Queen Charlotte Islands, a mild climate and high rainfall help to create some of Canada's most productive forest land. The abundant rainfall also supplies water for hundreds of small coastal streams, which provide spawning and rearing habitat for important sport and commercial fisheries -- another major contributor to the British Columbia economy.

Most areas of the Queen Charlottes are characterized by steep slopes and shallow, unconsolidated surficial materials that are subject to severe mass wasting. It was not until the late 1960's when most of the low relief terrain was logged, that forestry operations began on less stable hillsides. With steep side-hill yarding, the use of simple unimproved mid-slope roads became widespread, and it was not long before problems of soil instability were recognized as a serious threat to stream environments. Although no data are presently available to quantify the magnitude of logging-related landslides in the older cutover areas, it is obvious that damage from past events is extensive and that mass wasting continues to be a chronic source of sediment and debris entering productive salmon and steelhead streams.

A series of events that occurred in the late 1970's focused national attention on the Queen Charlotte Islands and on the problem of logging old-growth forest while protecting fisheries habitat. In 1978, a major storm triggered landslides throughout the Charlottes. The following year a less severe storm touched off slides in a clearcut area overlooking Rennell Sound on the west coast of the Islands, and these storms deposited sediment and debris in an ecologically important pink salmon spawning stream. The public outcry triggered by these landslides was widespread, and today there remains a strong lobby for the curtailment of logging in marginally stable terrain. Provincial and federal agencies have acknowledged that, although mass wasting is a natural process on the Charlottes, current timber harvest practices can

and do accelerate landslides in marginally stable terrain, where much of the remaining timber supplies are found. A task force appointed to analyze the problem recommended the need for research, and, in this context, the Canada Department of Fisheries and Oceans, the B.C. Ministry of Forests, and the B.C. Ministry of Environment agreed to undertake a 5-year interdisciplinary research program. The program not only assesses the impact of mass wasting on fish habitat and forest land, but seeks to determine the best methods (new or traditional) for logging steep slopes and rehabilitating damaged stream and forest sites.

The study, entitled the "Fish/Forestry Interaction Program", has as its overall objectives:

1. to provide documentation of the extent and severity of mass wasting impacts on fish habitat and forest site productivity;
2. to investigate the feasibility of rehabilitating stream and forest sites damaged by landslides;
3. to assess alternative silviculture treatments for maintaining and improving slope stability through the establishment and maintenance of thrifty root systems;
4. to investigate the feasibility and potential success of using alternative logging methods to reduce traditional environmental problems associated with logging. These methods include skyline and helicopter use, and improved planning of logging roads and logging layouts in sensitive areas; and
5. to provide land use managers with background information and new knowledge for decision-making on where and how to log steep, marginally stable terrain with minimal environmental damage.

The program began in 1981 with the selection and organization of the research team.

This report is intended to describe the interdisciplinary approach being used in the study and to illustrate one way in which government and other agencies can work together toward solving conflicts between fish and old-growth logging in a region heavily dependent on both resources.

1.1 The Study Area

The Queen Charlotte Islands are located off the central coast of British Columbia (Figure 1). They form an archipelago consisting of two main islands, Graham and Moresby, and approximately 148 others. The island chain stretches through Hecate Strait, 100 km from the mainland and about 250 km north of Vancouver Island. They have a land area of approximately 9940 km^2 and were intensively glaciated during the last major glaciation some 600 000 years ago (Sutherland-Brown 1968).

The Islands are divided into three major physiographic units having relatively distinct boundaries. These include the Queen Charlotte lowlands in the northeast of Graham Island, the Skidigate plateau which occupies much of central Graham Island, and the Queen Charlotte Ranges which form the backbone of the Charlottes and much of the west coast (Sutherland-Brown 1968).

Mass wasting is the dominant geomorphic process on the islands due to the modification of landforms by the glaciation, erosion, and weathering of bedrock and glacial deposits. The natural instability of the terrain is reflected in an abundance of colluvium which is found in thin veneers on steep slopes and ridges, and in aprons and fans along the base of slopes (Alley and Thomson 1978).[1] Mass movements occur in the form of open-slope failures (debris slides, debris avalanches, debris flows, and slump-earth flows) and V-notch gully failures (debris torrents). Mass movements are common features in both logged and old-growth forests.

A mild climate, high rainfall, and lack of summer drought in the Charlottes have created some of Canada's most productive forest land. Average annual rainfall ranges from about 430 cm in west coast fjords, to 115 cm on the east coast. Influenced by the Islands' close proximity to warm Pacific waters, air temperatures are predominantly mild. Mean daily

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[1] D.J. Wilford and J.W. Schwab. 1982. Soil mass movements in the Rennell Sound area, Queen Charlotte Islands, British Columbia. B.C. Min. For., Smithers, B.C. Unpubl. report.

FIGURE 1. Key map of the Queen Charlotte Islands.

air temperatures reach a summer high of 18° C and winter low of 2° C. Under these conditions forest growth is rapid. Increments of 1 m in leader height are common in many second-growth conifer stands.

In recent years the Queen Charlottes' forest land base has contributed in excess of 3% to the total provincial annual timber harvest (T. Dyer, B.C. Ministry of Forests, pers. comm.). The species that make up the cut include Sitka spruce (Picea sitchensis), western hemlock (Tsuga heterophylla), western redcedar (Thuja plicata), and yellow-cedar (Chamaecyparis nootkatensis). All of the timber currently being harvested is old-growth. The principal silviculture system is clearcutting, followed by natural regeneration and some commercial planting. The rotational period of second growth is estimated to be 70-100 years, with the first major commercial harvests not anticipated within 40 years (R. Haas, B.C. Ministry of Forests, pers. comm.). Current logging practices employ mainly cable yarding systems, most commonly highlead. Increasingly however, running skylines with grapple yarders and slackline yarders have been widely adopted to reduce slope disturbance due to yarding.

Nearly 200 streams on the Queen Charlottes contribute to commercial fish production and sport fishing. Total salmon escapement is estimated at roughly 1 million annually, amounting to almost 1% of the total provincial returning stocks (Can. Dep. of Fisheries and Oceans 1982). Most streams support populations of pink (Oncorhynchus gorbuscha), chum (O. keta), and coho salmon (O. kisutch). Some systems contain runs of sockeye (O. nerka) and a small number of chinook salmon (O. tshawytscha). Cutthroat (Salmo clarki) and steelhead trout (S. gairdneri) are two highly prized sport fish present in many streams. As well, Dolly Varden char (Salvelinus malma) is common to most systems.

1.2 The Research Team

Fish and forestry conflicts are not simply a product of clashes between resource managers and the timber industry. In fact, these conflicts involve a complex series of problems arising from the divergent responsibilities of these two groups, the concerns expressed by the

public, a lack of communication, insufficient understanding of landslide impacts, and differing policies among the various agencies responsible for land use management. While the research aims to develop a better understanding of logging impacts and solutions, the organizational structure of the program has been specifically designed to help solve some of the other problems contributing to the sources of conflict.

The commitment made by the two levels of government responsible for resource management to undertake the program on a co-operative basis has been essential in achieving organizational aims. This action has drawn together senior representatives of the agencies in a manner that promotes dialogue and common benefit from the research knowledge gained. A second important factor has been the adoption, by the participating agencies, of an "arm's length attitude" toward the research team. This approach has been chosen to demonstrate and maintain the objectivity of the team, and to develop trust among those agencies and industries directly concerned with the issues.

Program management and most project leader positions have been filled by contract personnel who are not associated with the sponsoring agencies and specialists from various government agencies and academic institutions have been invited to participate in the program.

The organizational structure of the Fish/Forestry Interaction Program is shown in Figure 2.

Responsibility for overall executive direction of the program lies with a Steering Committee consisting of senior representatives of the funding agencies and two other participating agencies (CFS and FERIC). Technical direction and contract supervision are provided by a Technical Advisory Committee comprised of district, regional, and branch staff from the funding agencies. A Scientific Advisory Panel has been incorporated in the program to provide further information to study design and research, and to serve as an important part of a technical review board for publications. Members of this committee are recognized scientists from British Columbia, Washington, and Alaska, thereby adding an international perspective to the study. In addition, the program has sponsored a Fisheries Employment Bridging Assistance Program.

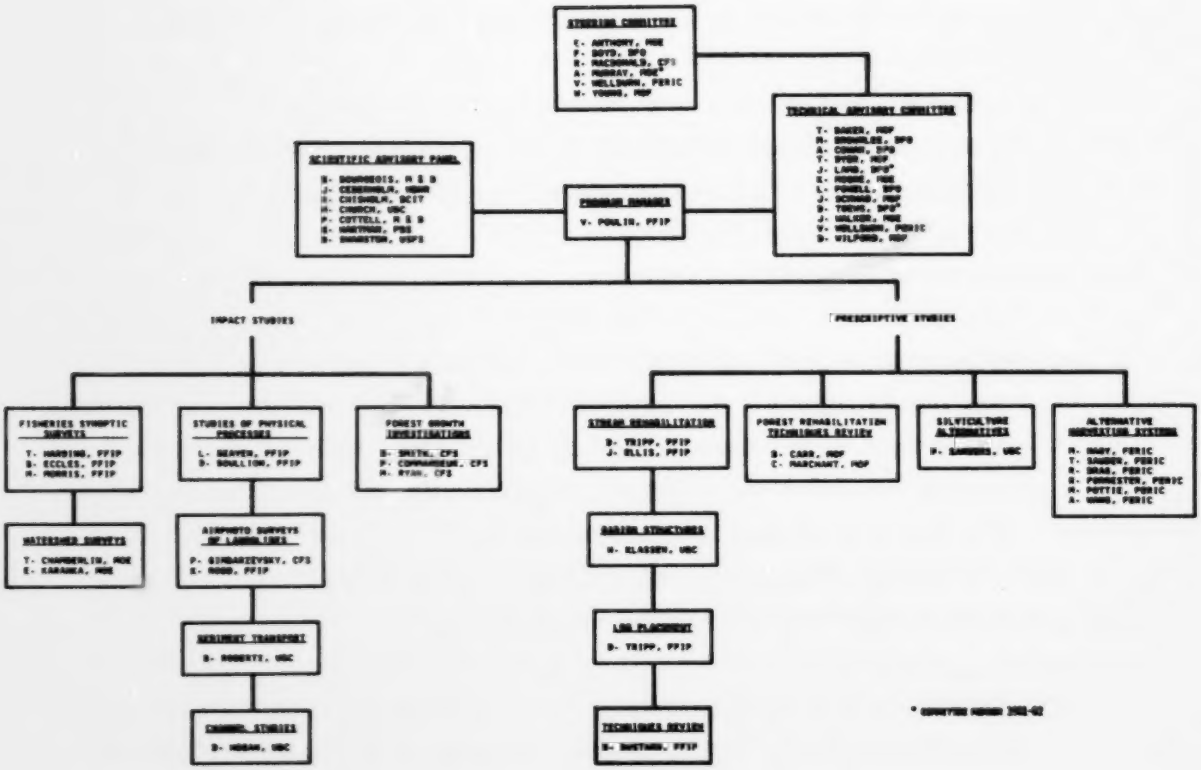

FIGURE 2. Project organization.

2 THE PROGRAM

To achieve the interdisciplinary objectives of the program, the study has been divided into four research components:

1. Synoptic Survey of Watersheds, which addresses the impact of landslides and subsequent soil erosion on fish habitat and forest land. Included in this component are the following research projects:
   - Watershed stratification
   - Landslide inventory and landform analysis
   - Morphological characteristics of logged and unlogged streams
   - Aggradation of stream channels: cause and effect
   - Fisheries investigations
   - Forest growth investigations

2. Stream and Forest Rehabilitation Studies, which aim at identifying methods to restore and improve productivity of streams and forest lands that have been affected by landslides. Studies include a review of forest rehabilitation techniques and two pilot projects dealing with stream rehabilitation:
   - Instream restoration using large organic debris
   - Spawning area improvement with gabions

3. Silviculture Investigations, which attempt to determine ways in which forest management techniques can be used to maintain and improve slope stability. A review of potential silviculture methods and techniques is one such investigation.

4. Alternative Harvesting Studies, which examine different methods for planning logging roads, logging layouts, and log yarding to determine how landslides can be avoided with improved forest engineering and alternative yarding techniques, such as skylines and helicopters.

3 STUDY DESIGN

Resolution of logging/landslide conflicts can only be achieved through a better understanding of forest harvest impacts and through the successful application of management prescriptions that reduce or mitigate damage caused by landslides. Figure 3 illustrates how the various research components are combined to provide an integrated program directed at "applied problem solving."

The four major study components within the program fall into two broad categories of investigation. The first category involves impact studies, and deals with assessing the impact of landslides on forests and streams. It is referred to as the "Synoptic Survey of Watersheds". The second category involves prescriptive tools which, if found to be successful, may provide land use managers with the means to log steep slope terrain in a more environmentally acceptable manner. These projects include the "Stream and Forest Rehabilitation Studies", the "Silviculture Investigations", and the "Alternative Harvesting Studies".

3.1 Synoptic Survey of Watersheds

The synoptic survey of watersheds is a 2-year investigation that follows the extensive post-treatment approach suggested by Hall and Knight[2] for what is considered to be an improved study design for impact assessment. We have combined that approach with one that includes more detailed study of a few streams to examine special processes. Field studies are being carried out in some 30 logged and unlogged watersheds, allowing the range and magnitude of impacts attributed to landslides to be observed. The spatial and temporal perspectives offered by this approach permit wider extrapolation of study results within the short time of the study.

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[2] J.D. Hall and N.J. Knight. 1981. Natural variation in abundance of salmonid populations in streams and its implications for design of impact studies. U.S. Environmental Protection Agency, Corvallis, Oreg. Reprint of paper to be published in NTIS Series.

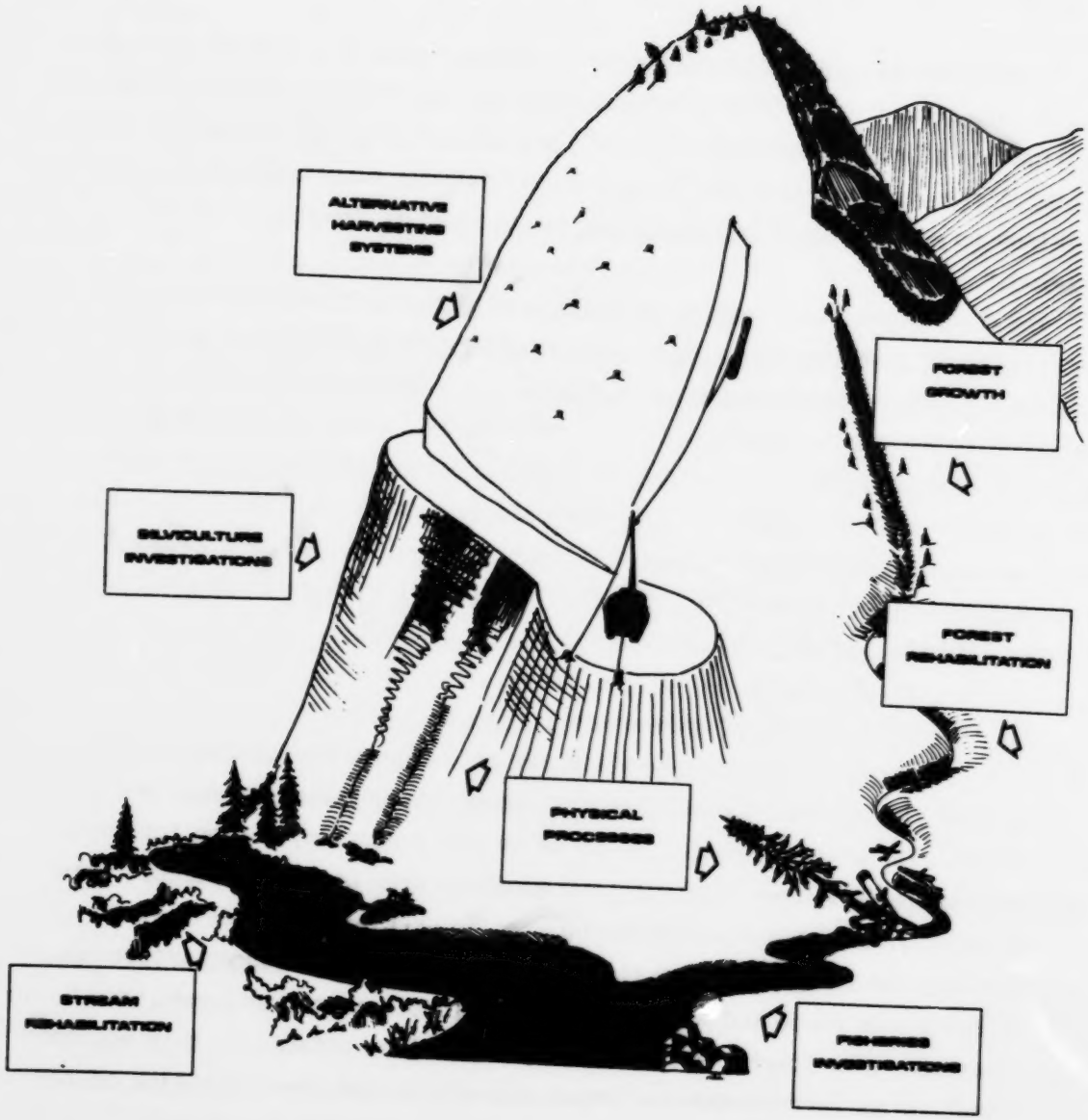

FIGURE 3. Study components.

Included within the synoptic studies are fisheries investigations, studies of physical processes (landform analysis and fluvial geomorphology), and forest growth. The fisheries investigations have been designed to assess the effects of eroded material and stream scour on fish rearing and spawning habitat, and on the rate of stream recovery. Measurements of the amount of pool riffle and glide habitat are being taken in each watershed to quantify the extent of instream habitat affected by landslides. Standing stock information is collected at summer low flow, pre-fall freshet, and winter low flow so that effects upon stream production can be assessed. Effects of sediment on spawning gravel quality are being examined in each stream system.

To establish a correlation between mass wasting and damage to fish habitat, landform analysis and studies of channel geomorphology are being carried out at two levels. For each of the study watersheds a landslide inventory is being prepared from air photographs (at a scale of 1:10 000) to provide information on the number of slides, size, and volume of material potentially delivered to fish habitat. The analysis also includes a description of failure site characteristics as defined by air photograph interpretation. The inventory will permit an analysis of the role of past and present logging practices on the rate and severity of landslide events, and will possibly lead to development of a quantitative expression for predicting the probability of failures in unlogged terrain.

A major emphasis of the physical studies is to describe both the role of sediment transfer from the hillslope to the stream and the effects of landslide material on channel morphology. Two post-graduate studies have initiated this work. The first study is an examination to assess fluvial responses to logging. The second focuses upon understanding the origin and source of gravel depositions in streams that have been observed to cause dewatering and loss of fish habitat.

Studies to determine the effects of mass wasting on forest site productivity and vegetative succession are proceeding on a synoptic basis. Work is being conducted on 45 slide tracks, covering all the major bedrock types found on the Charlottes. Knowledge of landslide effects on

forest sites is basic to the planning and justification of hillslope restoration, and is expected to aid in predicting realistic wood yields and in calculating future annual allowable cuts in areas susceptible to mass wasting.

3.2 Stream and Forest Rehabilitation

Resolution of fish and forestry conflicts can be facilitated by the mitigating effect of habitat restoration. A major component of the program aims at developing vegetative control measures that will reduce soil erosion and increase soil productivity on the hillslopes.

Two stream rehabilitation studies are proposed. The first involves restoration of a debris-filled torrential creek, using large organic debris. The objective is to determine if simple log placement can speed stream recovery after scouring by a debris torrent. The second project proposes to evaluate the use of wire gabions for stabilizing spawning habitat.

3.3 Silviculture Investigations

A problem analysis of silviculture alternatives is being undertaken to identify pilot studies. Projects to be considered include evaluations of strip clearcuts, shelterwood systems, and reforestation techniques. The objective is to seek systems or techniques that will establish and maintain a network of live root systems to offset root weakness caused by decay.

3.4 Alternative Harvesting Studies

The alternative harvesting studies involve two sub-components. The first involves evaluation of current logging planning methodology, to determine whether improved technology can reduce the number of landslides attributed to the operations. The study will plan three logging settings according to current engineering practices, and will compare these with another series based on more extensive engineering surveys and more detailed information. The outcome of the study is intended (1) to define

the limitations of present logging plans in dealing with landslide problems, and (2) to identify the level and type of information that must be available at the engineering stage to enable detection and mitigation of potential landslide problems, with their associated costs and benefits.

The second sub-component of the harvesting studies examines the cost and benefits of alternative harvesting systems for use on marginally stable terrain. Experimental yarding that uses full-suspension systems, including skylines and helicopters, is planned to determine whether new methodologies and equipment will enable more environmentally acceptable logging on steeper slopes.

4 PROGRAM TIMING AND OUTCOMES

The timing of the major study components is shown in Figure 4. The synoptic studies will be completed at the end of our 1983-84 fiscal year, with results compiled in an interdisciplinary program publication addressing the effects of landslides on stream and forest systems on the Queen Charlotte Islands. The prescriptive studies will terminate at the end of the following year and be presented as an interdisciplinary report describing management options and recommendations for steep slope logging, landslide prevention, and mitigation. A general conference inviting scientists and industry to discuss the program results will be held the same year. Internal working papers and technical reports will be published annually and contained in a volume series with copies available on request. The program will also produce a semi-annual newsletter featuring results of selected studies.

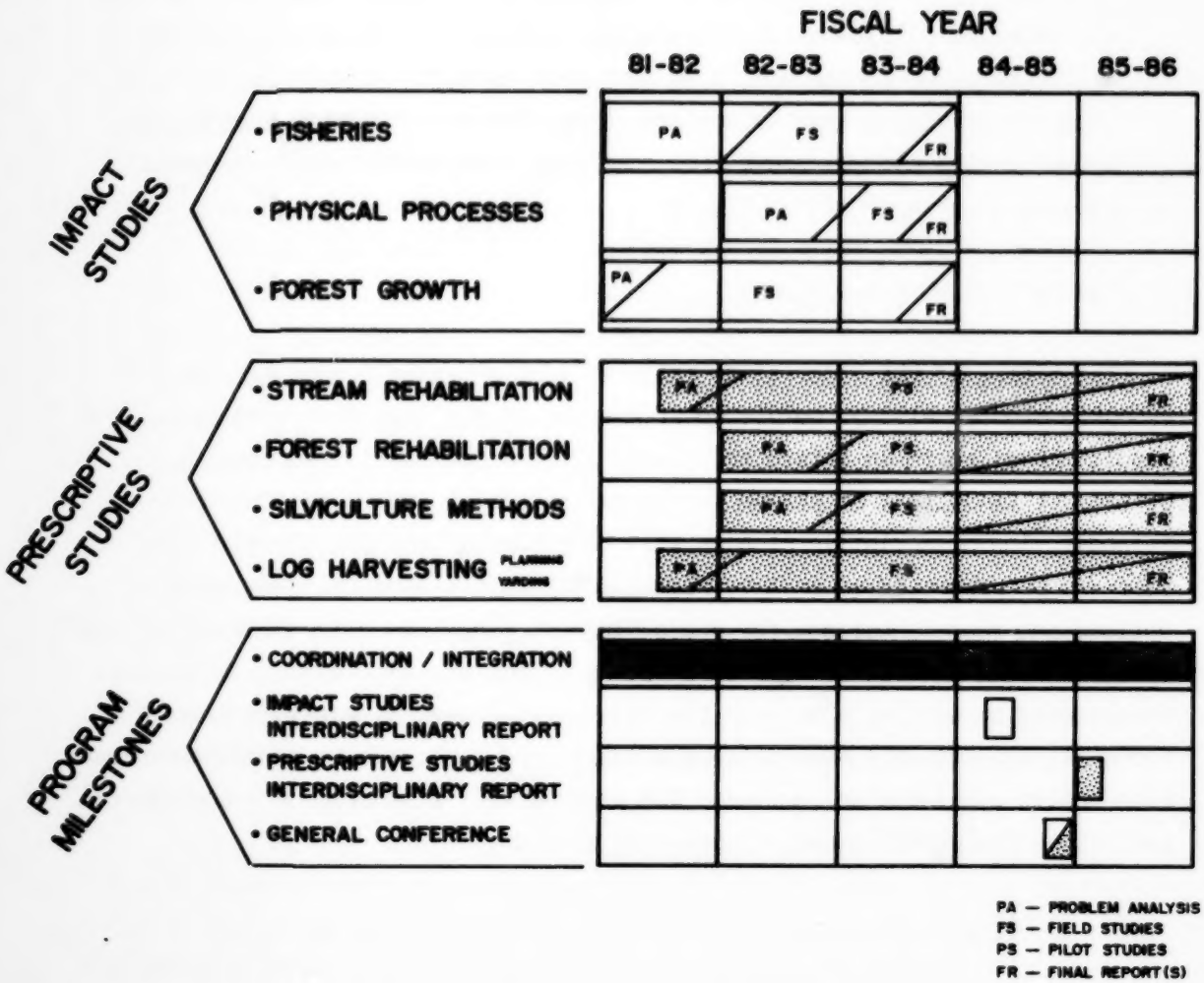

FIGURE 4. Timing of major study components.

5 RELATIONSHIP TO OTHER STUDIES

The Fish/Forestry Interaction Program is the first major interdisciplinary study to concentrate its efforts on assessing the impact of soil mass movements on fish habitat and its linkage to timber harvest operations. The program complements other British Columbia research initiatives including the continuing Carnation Creek Project begun in 1972, which is assessing the effects of logging on a small, west coast watershed on Vancouver Island (Narver and Chamberlin 1976; Hartman (editor) 1981); and a 4-year study (1971-1975) in the Slim-Tumuch Creek watersheds, which is providing information on the effects of logging on lake and stream systems of central British Columbia (P. Slaney, B.C. Fish and Wildlife Branch, pers. comm.).

This program augments slope stability research already under way in British Columbia as well as in Japan, New Zealand, Austria, and the United States. Apart from recent research on soil mass movements in the Rennell Sound area of the Queen Charlotte Islands,[3] the most significant association is with the U.S. Forest Service Interstation Soil Mass Movement Research Program, which involves scientists throughout Alaska and the Pacific Northwest. This long-term program, initiated in 1972, is examining soil mass movement mechanics and qualifying effects of road construction and clearcut logging on slope stability in mountainous forests of northern California, Oregon, Washington, and Alaska.[4]

This program draws extensively on these research projects and other landmark logging studies, such as the Alsea Watershed Study in Oregon (Moring 1975), the Clearwater River Drainage investigations on the Olympic Peninsula (Cederholm *et al.* 1980), and the more recent stream ecological studies carried out in Porcupine Creek, southeast Alaska (Koski 1982). Research now under way in northern California's Redwood National Park (Kelsey *et al.* 1981) may provide a basis for future experimental design of similar efforts on the Queen Charlotte Islands.

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[3] Wilford and Schwab. 1982.

[4] D.N. Swanston. 1979. Revised interstation problem analysis (PNW, PSW, Int. and RM). Effects of forest operation on natural slope stability and accelerated soil mass wasting on mountainous forest land. U.S. For. Serv., For. Sci. Lab., Juneau, Alaska. Unpubl. Internal Report.

6 LITERATURE CITED

Alley, N.F. and B. Thomson. 1978. Aspects of environmental geology, parts of Graham Island, Queen Charlotte Islands. B.C. Min. Environ., Res. Anal. Br., Bull. 2. Victoria, B.C.

Cederholm, C.J., L.M. Reid, and E.O. Salo. 1980. Cumulative effects of logging road sediment on salmonid populations in the Clearwater River, Jefferson County, Washington. In: Salmon-spawning gravel: A renewable resource in the Pacific Northwest? Conf. Proc., Oct. 6-7, 1980. (editor). Seattle, Wash.

Hartman, C.F. (editor). 1981. Carnation Creek Project Report for 1979 and 1980. 5th Report on Carnation Creek Project, Pacific Biological Station, Nanaimo, B.C.

Kelsey, H., M.A. Madey, J. Pittick, P. Stroud, and M. Coghlan. 1981. Major sediment sources and limits to the effectiveness of erosion control techniques in the highly erosive watersheds of north coastal California. In: Erosion and sediment transport in Pacific Rim steeplands. IAHS Publ. 132. Christchurch, N.Z.

Koski, K. 1982. Old-growth-stream ecosystem: Part 1. Characteristics of Porcupine Creek, a small stream in South East Alaska. In: A symposium on old growth forest-fisheries ecology. (editor). Juneau, Alaska.

Moring, J.R. 1975. The Alsea watershed study: effects of logging on the aquatic resources of three headwater streams of the Alsea River, Oregon. Part III. Discussion and recommendations. Oregon Dep. Fish and Wildlife. Fishery Res. Rep. 9.

Narver, D.W. and T.W. Chamberlin. 1976. Carnational Creek: an experiment towards integrated resource management. Fish. Mar. Serv., Circ. 104.

Sutherland-Brown, A. 1968. Geology of the Queen Charlotte Islands, British Columbia. B.C. Dep. Mines and Petroleum Res. Bull. 54. Victoria, B.C.